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Morphological classification of post-AGB stars

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Abstract. We present a complete study of the morphology of post-Asymptotic Giant Branch (AGB) stars. Post-AGB is a very short evolutionary phase between the end of the AGB and the beginning of the Planetary Nebula (PN) stage (between 100 and 10,000 yrs). We have defined the end of the post-AGB phase and the beginning of the PN phase when the star is hot enough to fully ionize the hydrogen envelope. Post-AGB stars have a circumstellar shell that is illuminated by the central stars or partially ionized. However, this circumstellar shell is too small to be resolved from ground-based observations. Thus, we have used data from the Hubble Space Telescope (HST) database to resolve these shells. About 150 post-AGB were found in this database. Here we present the preliminary results on their morphological classification and the correlation with several parameters such as galactic latitude and IRAS fluxes. Our preliminary results show that 40 % of the sample are stellar-like (S), 33 % bipolar (B), 12 % multi-polar (M) and 15 % elliptical (E).

As has been shown over the past 30 years, the study of the Planetary Nebulae (PNe) morphologies provides valuable information about the late stages of stellar evolution. The processes that lead to the different morphologies observed in PNe (Manchado 2003) are not known in detail.

Because of the short-lived (10^2 - 10^4 yrs) nature of the post-AGB transition phase, the number of known objects is scarce. In addition, the physical size of the observed nebulosities is very small (between 1 to 10 arcseconds on the sky), making ground-based observations very difficult. The post-AGB nebulosities can display an incipient bipolar structure at a very early stage in the post-AGB phase, as has been demonstrated by the Hubble Space Telescope (HST) observations of different samples of post-AGB stars (e.g., Ueta et al. 2000, Sahai et al. 2007, Siodmiak et al 2008). However, there is a general perception in the literature that most of the observed post-AGB stars display asymmetrical (e.g., bipolar, multi-polar, etc.) structures. This is in an apparent contradiction with the morphologies observed in more complete samples of evolved PNe, where round (25%), elliptical (58%) and bipolar and multi-polar (17%) PNe are observed (Manchado 2003). This contradiction is most likely related to a strong bias when selecting post-AGB samples, as well as the fact that almost all authors in the

literature report and discuss the high-spatial resolution images only of the post-AGB objects that show some extended structure. Here we present a complete and less biased study of the morphology of post-AGB stars in order to shed some light on the possible reasons of this apparent contradiction between the morphologies observed in PNe and their immediate precursors, the post-AGB stars.

We have selected a large sample of post-AGB candidates showing infrared colors similar to PNe (Manchado et al. 1989, Garcia-Lario et al. 1997). This sample was complemented with the Torun Catalogue of post-AGB stars and related objects (Szczerba et al. 2007) as well as with previous surveys based on ground-based optical spectroscopy (Suarez et al. 2006) and HST imaging of post-AGB stars (e.g., Ueta et al. 2000, Sahai et al. 2007, Siodmiak et al 2008). Note that we have defined the end of the post-AGB phase and the beginning of the PN phase when the star is hot enough (spectral type earlier than B) to fully ionize the hydrogen envelope.

We have searched the HST database (http://archive.stsci.edu/) and downloaded images for 140 post-AGB stars obtained with the ACS, WFPC, WFPC2, and NICMOS instruments onboard HST. The available images were analyzed and all post-AGB stars were morphologically classified as stellar-like, round-elliptical, bipolar and multi-polar.

From the sample of 140 post-AGB star, 25 could not classified, because several factors, e.g. we could not identify the star or the morphology did not follow the classification scheme. The rest of the sample could be divided in four morphological classes, with 46 (40%)objects being stellar like (S), 38 (33%) Bipolar (B), 14 (12%) multi-polar (M) and 17 (15%) elliptical (E). It is specially remarkable that non round post-AGB were found, on contrary which is found in PNe(25%)

1. Results

When studying, the Galactic distribution of post-AGB and PNe, it is remarkable that most of the post-AGB are concentrated around the galactic plane in comparison with PNe. S type seems to be the around the galactic bulge, and have a higher Galactic latitude distribution together with the E type than the B and M. This is similar to what is found in the PNe sample.

The post-AGB morphological distribution is different to that of PNe, with a lack of round ones. There is a strong bias towards the Galactic plane in comparison with the PNe sample. This may be due to a strong observational bias.

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